SOME NOTES ON LIFE HISTORY OF LADYBEETLES.*

By Miriam A. Palmer

The species treated in this paper are the more common forms found in Colorado; namely, *Hippodamia convergens* Guer., *Coccinella 5-notata* Kirby, *Coccinella monticola* Muls., *Coccinella 9-notata* Hbst., and *Adalia melanopleura* Lec., *annectans* Crotch, *coloradensis* Casey, and *humeralis* Say; also incidentally, *Olla abdominalis* Say, *Hippodamia sinuata* Muls., and *parenthesis* Say, *Coccinella sanguinea* Linn., and *Scymnus* sp. Special attention was paid to the duration of the life cycle, and habits regarding egg-laying and feeding, with incidental observations on injurious influences and other points, also descriptions were made of the beetles in all stages.

Hippodamia convergens Guer.

This is our most common species, and may be described as follows:

Adult: Fig. 1, Plate XXXII.

Head black, with pale frontal spot connected laterally with the eyes; pronotum black with pale narrow border along apical and lateral margins; the two discal marks distinct and converging posteriorly; elytra yellowish red, each with a scutellar spot and with six other spots rather small in size and never united; the three posterior ones more developed and constant. The spots are frequently lacking altogether and the elytra immaculate. Legs black; length 6 to 7 mm.; width 3.5 to 4 mm.

Egg: Fig. 2, Plate XXXII.

Pale to deep amber yellow, even as deep as yellow cadmium in some cases; length 1.13 to 1.33 mm.; width .49 to .55 mm.

Larva: Fig. 3, Plate XXXII.

First instar: Entirely black with exception of pale area on lateral and dorso-lateral margins of first abdominal segment; meso- and metathorax each with two large setaceous areas and small setaceous spot laterally; abdomen with three pairs of rows of setaceous areas. Second instar: Same as first except that margins of pronotum are often pale yellowish and the pale spots on the first abdominal segment are now light orange colored, and in addition to these, faint orange spots are seen similarly placed on the fourth segment. Third instar: Same as before except that it is more orange colored in the light spots. Fourth

*This paper is an outgrowth of breeding cage work with the Coccinellids, assigned me by Professor Gillette as a part of his Adams fund project on Life Histories of the Plant Lice and Their Enemies. Acknowledgments are also due to Professor C. P. Gillette and Mr. L. C. Bragg for determination of Plant Lice herein mentioned.

instar: Same as third except for the addition of pale orange spots on the 6th and 7th segments on dorso-lateral portion, not extending laterally. Some larvæ show quite a bluish frosted appearance over the black, more especially toward the later stages. Length about 9.5 mm. for a full grown larva.

Pupa: Fig. 4, Plate XXXII.

Ground color brownish yellow throughout; pronotum with black lateral margin and an anterior and a posterior pair of black spots; wing pads black along posterior margin and over apical half; each segment with sublateral and medio-lateral spots. Spiracles black. Sometimes much lighter in general color and only a dot found on wing pad at basal third. Legs black. Length 5 mm.

Life cycle records* were made as follows:

Egg stage (22 records*) 3-7 days, mostly 3 days;
Larva stage (22 records) 10-28 days, mostly 14 days;
Pupa stage (22 records) 4-9 days, mostly 4-5 days;
Egg to adult, mostly 21 days.
Adult stage (13 records) 3-4 months for the summer generations.

A hibernating female lived 8 months and 12 days, dying May 25th, having laid eggs from April 27th to May 19th. This female would doubtless have lived longer under natural conditions. The weather was wet and unfavorable and the female was evidently in a weak or unhealthy condition as evidenced by the poor hatching of all the eggs. Another hibernating female lived until July 6th. All the females which had laid eggs before going into hibernation died either during the winter or in the spring before laying any eggs. A male which had hibernated lived 9 months and 8 days, dying June 13th.

The earliest egg record obtained was April 27th, the latest record in 1908 was September 3rd, and in 1907, was October 30th. The earliest beetles reared emerged June 22nd and the last one lived until September 22nd. Under natural conditions and in early spring, doubtless the first generation emerges as soon as the latter part of May or even earlier, according to the season. There were at least three generations obtained in a season.

The females would usually begin to lay within five days after emerging and the longest egg-laying record obtained was 1 month and 18 days. Several egg counts were made. They are as follows: 130 eggs (in 20 days), 199 eggs, 296 eggs, 312 eggs (in 1 month and 15 days), and 399 eggs, by different

*The term, record, in this sense shall be understood to mean, not notes made on a single individual, but on an egg patch and the beetles resulting therefrom.

females respectively. These numbers are certainly far below what the beetles are able to lay under favorable conditions in a state of nature. The number of eggs laid in a single batch was usually about 30, though the number varies considerably both above and below this number. When in good laying condition a female will deposit from one to two batches a day.

Food records.—Several records were taken on the feeding capacity of both larvae and adults for plant lice. One larva ate 50 *Prociphilus fraxinifolii* Riley, another half grown, ate 33 *Macrosiphum gaurae*, and another half grown, ate 105 *Chait. negundinis* Thos., in a single day. Entire counts of the whole number of lice eaten during the larval period were taken in four cases and are as follows: 264 (57 *M. gaurae*, 56 *Chaitophorus negundinis*, 151 *P. fraxinifolii*), 309 (71 *M. gaurae* 137 *C. negundinis*, *101 P. fraxinifolii*), 585 (423 *C. negundinis*, 72 *P. fraxinifolii*, 90 *M. rosae* Linn., small), and 576 (263 *C. negundinis*, 54 *M. rudbeckiae* Fitch, 114 *P. fraxinifolii*, 57 *S. schizoneura lanigera* Hausmann, and 88 *M. rosae*), of all sizes, by each larva respectively.

A pair of beetles, male and female, ate 150 *Chaitophorus populifolii* Fitch, in one day, and 120 *Aphis setariae* Thos., on another day. A male made the following records on different days respectively: 200 *M. gaurae* Will., 30 *M. rudbeckiae*, 33 *A. torticauda* Gill., 60 *C. negundinis*, and 75 *M. cerasi* Fab., these lice being of all ages and sizes.

A female ate on different days, 36 *M. rudbeckiae*, 180 *C. negundinis*, 165 *M. cerasi*, 110 *A. helianthi* Monell, and 120 *A. setariae* respectively.

The amount eaten varied very considerably on different days. For 12 hours before molting the larvae would sometimes eat comparatively little, while for several days before pupating they would be extremely voracious. Female adults always ate the most when laying eggs. The temperature also affected their appetites very remarkably, the highest records being made on dry hot days, while in damp cool weather they often ate almost nothing.

The state and temperature of the weather was indeed a very important factor in the welfare of these insects. Cold damp weather would very much retard the rate of growth of the larvae and the egg-laying of the females and would seem to

encourage diseases. Another injurious influence was the practice of cannibalism among the larvae and also the eating of eggs and pupae by both adults and larvae. A female would often eat her own eggs. As a rule, these habits were not practiced unless there was scarcity of food and in some cases not even then, while in other cases these deeds would be perpetrated with apparently no excuse. Individuals seemed to differ widely in this respect. Some kinds of lice proved injurious in the breeding cage. Large lice such as *M. rudbeckiae* and *M. ambrosiae* Thos., caused the death of several beetles by smearing their mouths shut by means of the glue extruded from the cornicles so that the beetles starved to death. Probably the results would not have proved fatal, had the beetles not already been somewhat weakened by other injurious influences, and were it not for the unnatural conditions of the breeding cage so that the lice were restless and walking about constantly.

The larvae, especially in the younger stages, seemed to prefer smaller lice in the cages, though out of doors they were frequently found feeding on large ones with no apparent difficulty. This protective function of the cornicles, however, would probably, even in nature have more or less of an injurious effect on the beetles.

This ladybeetle seems to be a very general feeder on plant lice. One beetle was observed to eat a larva of *Aphidoletes marina*, a dipteron, which is also predaceous on plant lice, but whether it would make a practice of this in nature was not ascertained, probably not, as in other cases the larvae of *Aphidoletes* were rejected. An unusually hungry beetle or larva would often chew or suck about on the leaves which were put into the cage with the lice. They seemed to do no visible injury to the leaves and were probably only sucking and licking off the honey dew left by the aphids. Both the beetles and larvae refused to eat chrysomelid eggs and membracid larvae which were offered to them. No evidence was obtained of their feeding, to any appreciable extent, on anything besides the living plant lice. They do not seem to touch even newly laid eggs of Aphididae.

The species of aphididae which were used for food in the breeding cage were as follows: *Aphis gossypii* Glover, *A. oxybaphi* Oest., *A. carbocolor* Gill., *A. torticauda* Gill., *A. helianthi*

Mon., *A. pomi* De Geer, *A. cerasifolii* Fitch, *A. medicaginis*, Koch, *Phorodon humuli*, Schrk., *A. oenotherae* Oest., *A. brassicae* Linn., *Chaitophorus negundinis* Thos., *C. populicola* Thos., *C. populifolii* Fitch., *Macrosiphum ambrosiae* Thos., *M. rudbeckiae* Fitch., *M. pisi* Kalt (?), *M. rosae* Linn., *Hyalopterus arundinis* Fab., *M. cynosbati* Oestl., *Lachnus* sp., *Melanoxantherium smithiae* Monell, *Myzus cerasi* Fab., *Prociphilus fraxinifolii* Riley, *S. lanigera* Hausm, and *Melanoxantherium bicolor* Oestl.

Outdoors they were observed feeding on *A. pomi*, *M. rudbeckiae*, *C. negundinis*, *Myzus cerasi*, *Mac. on Euphorbia*, *A. atriplicis* Linn., *M. pisi*, and *M. cynosbati.* Although these were all the lice noted, *H. convergens* has been found feeding on practically all of the common plant lice; in fact, it does not seem to be at all particular, and, both because of the wide range of its feeding habits, and on account of the comparative hardiness of constitution, probably does as much or more in controlling the plant lice than any other *Coccinellid.*

Hippodamia sinuata Muls.

This species also is a comparatively common ladybeetle about Fort Collins Colorado though it does not seem to rank very high in economic importance in this vicinity.

Adult: Fig. 5, Plate XXXII.

Head black with fine apical line of whitish and median pale spot connected laterally with the eyes. Pronotum black with pale border along anterior and lateral margins with tendency to abbreviated acute line before, though this is often wanting; two converging discal marks as in *convergens;* elytra yellowish red with suture black from one to three-fourths of entire length and each with four spots, the first near humeral angle, the second, a large one, just back of the middle, near the suture, the third slightly caudo-lateral of this, and another at apical fourth, the second and third spots very often united and frequently humeral spot, also, joined to second spot by means of vitta, coalescence of third and fourth spots occasionally occurs, thus completing the entire amalgamation of all the spots; legs black; general shape rather narrow; length 5-6 mm., width 3-3.9 mm.

Egg: Fig. 8, Plate XXXII.

Amber yellow; length 1.4 mm.; width .6 mm.

Larva: Fig. 7, Plate XXXII.

First instar: Black except pale spot on lateral margin of first abdominal segment and lateral and dorso-lateral of fourth abdominal segment. Second instar: same as first except that pale spots are more pronouncedly yellowish. Third instar: same as preceding but spots

have become orange and in addition the anterior and posterior borders of the pronotum have become yellow orange (pale), also dorso-lateral spots of yellow on posterior margin of metathorax, (which seems to be a distinguishing mark in this species) and faint yellow spots dorso-laterally placed on fifth, sixth, and seventh segments, and whitish median line on all thoracic segments; length 8.5 mm.

Pupa: Fig. 6, Plate XXXII.

Ground color amber yellow covered with black except median line of yellow throughout though somewhat broken at segment margins; pronotum bordered with black; wing pads black except light spot on shoulder, meso- and metathorax with pair of black spots, abdominal segments black except median area and yellow orange spots on first and fourth segments laterally placed, fainter ones similarly placed on fifth, sixth, and seventh segments; legs black; length 5.7 mm.

Life cycle records were made as follows:

Egg stage (3 records) 3-6 days.
Larva stage (3 records) 21-23 days.
Pupa stage (1 record) 8 days.
Egg to adult, 32 to 37 days.

From these figures it would appear that the life cycle of this species was considerably longer than in the other species studied. This may, however, be partly due to the fact that these records were all made in the latter part of the summer so that the beetles were overtaken by cool weather towards the end of the larval stage.

In nature this species does not seem to be a very general feeder, being found, by Mr. Bragg, almost exclusively in the grass, or more especially on the *Carex*, feeding on *Rhop. braggii* Gill., and *Callip., flabellus* Sanb. In the breeding cage, however, it readily fed on *Mac. rudbeckiae*, *Mel. Smithiae*, *Aphis cornifolii*, *Rhop. pastinaceae* Linn., *Aphis heraclei* Koch, and *Chait. populicola.*

Hippodamia parenthesis Say.

This species ranks about equal with *H. sinuata* in economic importance.

Adult: Fig. 9, Plate XXXII.

Head black with pale abbreviated median dash from the front and a spot next each eye, usually connected with median line, sometimes entire front portion of face pale; thorax black with anterior and lateral margins and median abbreviated acute line before white, also square spot at base; elytra pale reddish with yellowish area in middle of posterior half, marked with common large spot near the base connected with the scutel, and each with humeral spot, and pair of parenthesis shaped

dashes on posterior half sometimes united into a single large lunule; legs blackish to black, tarsi brownish; general shape, somewhat pointed posteriorly; length 4-5 mm., width 2-3 mm.

Egg: Fig. 10, Plate XXXII.

Amber yellow; length 1 mm., width .4 mm.

Larva: Fig. 11, Plate XXXII.

First instar; general color grayish or blackish; head shining black except medio-anterior portion, setaceous spots black, as in all the other species reared, dorso-lateral and lateral portions of first and dorso-lateral portions of fourth abdominal segment pale, nonsetaceous portions of thoracic segments rather pale. Final instar; head black except medio-anterior portion, which is brown; pronotum bordered with pale, meso- and metathorax with whitish median portion; yellow markings as follows, lateral and dorso-lateral spots on first and dorso-lateral spots on fourth abdominal segments orange yellow, and faint indications of dorso-lateral spots on fifth, sixth, and seventh segments pale yellow; length 8 mm.

Life cycle records were made as follows:

Egg stage (1 record) 3 days.
Larva stage (1 record) 11 days.
Pupa stage (1 record) 6 days.
Egg to adult, 20 days.

This life cycle appears relatively short, but this is probably due to the fact that this batch was reared in July when the weather was specially favorable.

This species, like *H. sinuata*, has been found chiefly in the grass and *Carex* feeding on *Rhop. braggii* and *Chait. fabellus*, tho in the breeding cage it seemed to thrive on *Rhop. pastinceae*.

Coccinella 5-notata: Kirby.

Ranking next in order, or perhaps equal with *H. convergens* in economic value, is *Coccinella 5-notata*. This is somewhat larger and more robust species and may be described as follows:

Adult: Fig. 12, Plate XXXII.

Head black with triangular pale spot next each eye; pronotum black with subquadrate pale spot at the anterior angles; elytra brownish red, marked with common subbasal fascia and a transverse spot on each elytron before the middle, near the suture, and another at apical fourth. Sometimes the subbasal fascia is broken into three spots, sometimes there is also a dot on the anterior lateral portion of the elytra. Length 5.5 to 7.5 mm.; width 4.5 to 5.5 mm.

Eggs: Fig. 13, Plate XXXII.

Light to deep amber yellow in color; length 1.31 to 1.37 mm.; width .53 to .60 mm.

Larva: Fig. 14, Plate XXXII.

Indistinguishable from that of *H. convergens* until it reaches the third or fourth instar when the head becomes pale, except on the posterior and lateral margins, which remain black. Also, the yellow spots on the abdomen are usually a stronger orange color and the dorso-lateral spots on the 6th and 7th segments are lacking. The light blue frosted appearance is sometimes more pronounced than in *H. convergens.* Length about 12 mm., for a full grown larva.

Pupa: Fig. 15, Plate XXXII.

Ground color pale brownish yellow, tinged in places with pinkish, paler, as a rule, than in the case of *H. convergens.* Pronotum with narrow black margin all around, except on median posterior portion; wing pads black on posterior and apical two-thirds of anterior margin, also two spots, one at basal third, and the other at apical third. These spots often coalesce, darkening the whole apical two-thirds of the wing pad. On the metathorax is a pair of black spots on the posterior margin, medio-laterally placed; spots similarly placed on 2nd to 7th segments inclusive, which segments also show another spot just within the spiracles which often runs into the first mentioned spots along the posterior margin. On the 3rd segment, the black often covers the entire surface clear to the lateral edge, leaving only a pale line on the median. Seventh segment often pale or nearly so. The amount of black varies somewhat and is often less extensive, but the pupa can usually be distinguished from that of *H. convergens* by the more extensive black markings, and by the paler ground color, but this does not always hold. Legs black. Length, 6 mm.

Life cycle records were made as follows:

Egg stage (15 records) 3-5 days, mostly 3 days;
Larva stage (13 records) 11-19 days, mostly 13 days;
Pupa stage (12 records) 3-8 days, mostly 4 days;
Egg to adult, mostly 20 days.
Adult stage (4 records) 2-3 months for the summer generations.

The efforts to carry this species through hibernation all resulted in failure, but seven beetles were captured before May, 19, 1908, which, in all probability, had hibernated, as no larvae had been observed before that time or for some time afterwards. The last of these beetles lived until August 14th, and must have lived for nearly a year, as the beetles in the cages which went into hibernation began to emerge August 6th. In the cage of these seven captured beetles, eggs were found from May 19th to August 7th, a period of two months and eighteen days.

Egg records were made as follows: 368 eggs (in 2 months and 9 days); 469 eggs (in 1 month and 11 days), 532 eggs (in 1 month and 8 days), 539 eggs (in 1 month and 2 days) respectively. Single egg batches often contain as many as 60 eggs; the

average size, however, would be nearer 30 to 50. A beetle in good laying condition would often lay one or two batches a day, though in the breeding cage this rate was not kept up very long at a time.

The female would usually, under favorable conditions, begin to lay from four to ten days after emerging and continued in one case for one month and eleven days, and in another, the longest record, for two months and fourteen days. The third generation was reached in a season in the breeding cage and both 2nd and 3rd generation beetles went into hibernation but none survived, the hibernating quarters being unsatisfactory. The earliest eggs obtained in the spring were found May 19, 1908; the first generation began to emerge June 17th, and their first eggs were laid June 26th. The last of this brood lived until September 21st. The latest record of eggs obtained was September 14th. That year there was much cold wet weather during August, which very considerably checked the egg laying so that the beetles would very probably have laid for at least a month later under favorable conditions.

Records on the feeding capacity of both larvae and adults were taken as follows: One larva ate 595 and another 621 aphids during the entire larval period. The lice used in these counts were of all ages and sizes. One ate *C. negundinis* 333, *M. gaurae* 24, *P. fraxinifolii* 128, and *M. rosae* 110, total 595; the other *C. negundinis* 445, *M. gaurae* 18, *P. fraxinifolii* 88, and *M. rosae* 70, total 621. These lice were of all sizes. It will be seen that *C. negundinis* was used more than any other one species. One larva made the following records on single day counts: during the first instar, 30 *C. negundinis* in a day; 2nd instar, 84 *C. negundinis*; 3rd instar, 100 *C. negundinis* in a day. These were days when all was favorable and the larva was on full feed. An adult female when in best condition ate 200 *A. helianthi* in a day.

The plant lice used for feed were the same as used for *H. convergens*. This species seems to be just as general a feeder as *H. convergens* and, being somewhat larger, would naturally be expected to consume a few more lice, but it seemed to be more delicate in constitution so that it succumbed more easily to unfavorable conditions in the breeding cage. This species was affected by the same injurious influences as were mentioned for *H. convergens*.

In 1907 and 1908 this species, from casual local observations, seemed to rank next to *H. convergens*, which was first in numbers, but in 1909 it seemed to rank about fifth, with *H. convergens* sixth. During this year, the first in numbers seemed to be *C. monticola* which, during the two previous years, had ranked third.

Coccinella monticola Muls.

This species is quite similar in general appearance to *C. 5-notata* and may be described as follows:

Adult: Fig. 16, Plate XXXIII.

Head black with triangular spot next each eye as in *C. 5-notata;* pronotum black with quadrate pale spot at the anterior angles; elytra brownish red, with common scutellar spot, and on each a broad transverse oblique median fascia and a shorter subapical one black. Sometimes the median fascia is broken, leaving a small spot laterally. Legs black. Length 5 to 7.5 mm.; width 4 to 4.75 mm.

Egg: Fig. 17, Plate XXXIII.

Same as in *C. 5-notata.*

Larva: Fig. 18, Plate XXXIII.

Same as in *C. 5-notata*, except that in 3rd and 4th instars the head is pale clear to the posterior margin, while *C. 5-notata* almost always has a line of black along the posterior margin. Length of full grown larva about 12 mm.

Pupa: Fig. 19, Plate XXXIII.

Ground color pale brownish yellow, usually paler than in *C. 5-notata*, sometimes with pinkish spots on lateral portions of 1st and 4th segments of the abdomen where the orange spots were in the larva. Black markings were as follows: Three spots on anterior edge of pronotum, and one on posterior lateral margin, wing pads with two transversely duplex spots, one at basal third and the other at apical third, and a spot at base close to posterior lateral margin, which margin is also black; median pair of spots on metathorax, also on 2nd to 6th abdominal segments inclusive, smallest on 2nd; 3rd to 6th abdominal segments also with spot within spiracles largest on third and inclined to extend to the very margin of the segment. Knees black, remainder of legs usually paler. Length 6.5 mm. The pupæ of this species can usually be distinguished from those of *C. 5-notata* by the less extensive black markings, though the two species vary so as often to be indistinguishable.

Life cycle records were taken as follows:

Egg stage (17 records) 3-8 days, mostly 4 days;
Larva stage (11 records) 12-14 days, mostly 13 days;
Pupa stage (11 records) 4-8 days, mostly 6 days;
Egg to adult, mostly 23 days.
Adult stage (2 records of summer generation) 2 months and 6 days, and 3 months and 12 days respectively.

Three beetles captured July 15, 1907 hibernated and the last one died August 31, 1908, 13 months and 16 days from date of capture. In this cage, during 1907, only four eggs were laid, though it contained 9 beetles, but after hibernating, eggs were laid rather abundantly, though they were infertile, by one or more of the surviving three from May 11, 1908 to July 18, 1908, a duration of 2 months and 7 days. Three other beetles which were captured May 15, 1908, and in all probability had hibernated, lived until September 8, 1908, so they must have been a year old, at least, eggs having been laid from May 18, 1908 to August 18, 1908, a period of three months.

No egg records were taken on this species, as only captured females laid at all satisfactorily and these had doubtless laid a portion of their eggs while still out of doors, so a complete record could not be gotten. The earliest eggs obtained in the spring were found May 11, 1908, laid by females which had hibernated in captivity; June 16, 1909, from captured females. The latest record obtained in the fall was September 3, 1909, but as this was the only year that a record was taken and as August was very wet and cool, the beetles would probably be able to lay for a month later, at least, under favorable conditions.

The earliest generation reared emerged June 24, 1908, and began to lay July 17, 1908, and the last beetle died September 15, 1908, probably due to the unfavorable weather. Later batches of the same generation which emerged July 4, 1908, later went into hibernation but died during the winter. Beetles emerging July 5, 1909, the earliest generation obtained that year, went into hibernation.

It seems that this species may have both one and two generations in a year, since some of what were evidently first generation beetles went into hibernation while others of this same generation laid eggs, infertile though they were, and died before winter.

In feeding capacity they were about the same as *5-notata*. One larva from time of hatching to pupation ate 388 plant lice, (23 *A. torticauda*, 65 *C. negundinis*, 165 *C. populicola*, 90 *A. setariae*, 45 *M. ambrosiae*); another ate 376 plant lice, (12 *A. torticauda*, 120 *A. setariae*, 174 *C. negundinis*, 40 *C. populicola*, 30 *M. ambrosiae*). another ate 901 plant lice, (150 *A.*

gossypii, 480 *A. helianthi*, 19 *A. setariae*, 82 *C. populicola*, 140 *A. pomi*, 30 *M. rudbeckiae*); and another, 962 plant lice, (774 *A. gossypii*, 108 *M. pisi*, 80 *Myzus cerasi*). One larva during the first instar ate 30 *A. gossypii* in a single day; in the 2nd instar, 100 to 130 *A. gossypii*; third instar, 150 *A. gossypii*. Of course these records were made when all conditions were favorable. No records were taken on the adult.

The range of feed seemed to be the same as for *H. convergens* and *C. 5-notata*. They were observed out doors feeding on *A. pomi*, *H. arundinis*, *M. cynosbati*, and *S. lanigera*. Though these were the only observations recorded they seem to feed on practically every common species of plant lice.

As to injurious influences, they seemed to be affected by the same factors as the foregoing species but seemed to stand cool wet weather rather better. Some of these beetles got rather badly pasted up by the glue from the cornicles of *M. rudbeckiae* but it did not result fatally. One beetle was found with one front foot glued fast to its head, probably the result of an attempt to clean itself for which operation the beetle was not sufficiently vigorous, the foot sticking fast until it dried.

A nearly full grown larva was observed to attack a good sized pupa of *M. ambrosiae*, biting it in the side of the third abdominal segment. The louse immediately struck the larva in the face with its cornicle and discharged a quantity of glue. The larva paid no attention to this but continued until it had finished the louse, and, inside of fifteen minutes, every trace of glue was removed. Evidently when the beetles and larvae are in vigorous condition this protective device of these aphids produces little result beyond temporary annoyance.

This species seems to be peculiar in several points of its life history as compared with the other *Coccinellidae* studied; first in the fewer generations in a season, and the consequent greater longevity of the beetles; and second, in the non-activity of the males. Mr. Bragg, who had dissected at least 100 *monticola* specimens, found only one male and he has some doubt as to its really being this species. No *monticola* has been observed in coition either indoors or out except with *C. 9-notata* or *C. 5-notata* males. The eggs of a female captured mated with *C. 9-notata* all proved infertile, even though the male was kept with the female for over two months and was frequently

observed in coition and the female laid a considerable number of eggs. A male of *9-notata* was introduced into a cage of *monticola* which had been laying infertile eggs and though he mated readily no fertile eggs were produced. One female *monticola* was taken in coition with a male *5-notata*. The eggs were fertile and produced all *monticola*, but this female may have been previously fertilized by another male so there is no evidence that the *5-notata* male had any effect.

There is a possibility of the males being weaker than the females and so being killed in the struggle for existence before they matured in the breeding cage, since about 50 per cent. were, as a rule, lost when a number were reared together. All the larvae from several batches were reared in individual cages. In this way 90 percent were brought to maturity and in the adult state all were put together in the same cage, but they always died down to the usual 50 percent before there was time for sexual development to be really completed, so that there is a probability in these cases of the males having been lost because of having a more delicate constitution than the females. This would also account for their scarcity out of doors.

Two batches were reared in individual cages, maturing 17 beetles from 18 larvae and 12 beetles from 23 larvae respectively. These beetles were not put together but were dissected by Mr. L. C. Bragg as soon as mature, the first lot proving to be 7 male and 9 female and the second lot 9 male and 3 female. This latter case seems evidence against the possibility of the males being weaker than the females, as in this batch little over 50 percent matured and 75 percent were males. The only explanation remaining seems to be a sexual non-activity for some reason.

A good share of the females captured proved to be infertile, when, however, a female is once fertilized it seems to suffice for the season. Females captured May 15, 1908, laid fertile eggs until August 18, 1908, a period of over three months, after which they very soon died.

In spite of this seemingly weak point in its life history, this beetle seems to rank quite high as an enemy of plant lice.

Coccinella 9-notata Hbst.

Description of adult, Fig. 20 Plate XXXIII.

Head black with pale triangular spot next each eye, or these spots may be connected so as to form a broad white band across the face; pronotum black with quadrate pale spot at anterior angles, and apical margin usually pale, often broadly pale; elytra bright brownish red or red ochre, with common scutellar spot, and each with four other spots, the two small ones sometimes connected by a fine line, one in humeral angle and the other near the lateral margin before the middle, and two large ones, one near the suture and before the middle, the other rather transverse and near the apex. Length 6-7.5 mm.; width 5-6 mm.

Egg: Fig. 21, Plate XXXIII.

Same as the foregoing species except, perhaps, a little smaller on the average.

Larva: Fig. 22, Plate XXXIII.

First instar: Entirely black or blackish gray, except pale dorso-lateral spots on first abdominal segment, and with setaceous tubercles as in the foregoing species. Second instar: Same as 1st except that median and anterior portion of head and anterior and posterior margins of pronotum are slightly pale or dusky, the spots on the first abdominal segment more yellow, and paler spots begin to show similarly placed on 4th abdominal segment. Third instar: Same as last except that pale portions of head and pronotum are lighter, and spots on abdomen are more orange colored. Fourth instar: Same as last except pale portion of head which is light yellow. The larvæ of this species seem to be identical in appearance with those of *5-notata* but do not grow to quite as large a size. Length of full grown larva 9.5 mm.

Pupa: Fig. 23, Plate XXXIII.

Ground color light reddish or brownish yellow, often with pinkish spots on 1st and 4th abdominal segments where the orange spots were located in the larva. Pronotum with a pair of black dashes on anterior margin, and a pair of black dots on the posterio-lateral margin; a median pair of black spots on metathorax and 2nd to 7th abdominal segments inclusive; Spiracles black; Wing pads with posterio-lateral margin black and a round black spot at basal third. This marking of the wing pad is comparatively constant and nearly always distinguishes it from all of the foregoing species, though sometimes this spot seems to spread apically so that the pupa cannot be distinguished from *5-notata*. Length about 6 mm.

Life cycle records were taken as follows:

Egg stage (14 records) 3-6 days, mostly 4 days;
Larva stage (8 records) 10-21 days, mostly 11-14 days;
Pupa (8 records) 4-5 days, mostly 5 days;
Egg to adult, mostly 20-23 days.
Adult (7 records) 2 to 3 months for the summer generations.

Some of the beetles which went into hibernation were then nearly four months old but did not survive the winter, probably on account of improper winter quarters. Only one beetle survived. It had emerged September 14, 1908, and lived until April 9, 1909

Four egg records were taken as follows:

435 eggs (in 1 month and 9 days); 493 eggs (1 month and 22 days); 950 eggs (in 2 months and 22 days); and 1047 eggs (in 2 months and 14 days). They laid from 40 to 68 eggs a day when in full laying condition. Some of these beetles began to lay as soon as one day after emerging. Others began at 7 days, and one at one and a half months after emerging. This latter was in all probability not normal.

The 2nd generation was reached in the season when the experiments were carried on, but, as a rather late start was made in the spring, it is more than probable that they are able to attain to the third generation when the spring is early. The earliest eggs obtained were June 11, 1909 and the latest record was September 2, 1909.

No exact feeding records were made with this species, but judging from general observation they seemed to consume as much as the foregoing species. Being as a rule somewhat smaller than *5-notata* and *monticola*, they probably ate a little less. They seemed to take to the same range of feed as the foregoing species in the breeding cage. This species seemed to be susceptible to all of the injurious influences already mentioned and besides these, several cases of parasitism were observed in beetles captured out of doors. After emerging, the parasite formed a silky cocoon underneath the beetle. The beetle, though still alive, seemed unable to leave the cocoon of its enemy and clasped it with all of its feet as though to protect it. One was carefully examined and found to be perfectly free from any attachment and the only reason for its remaining there seemed to be a partial paralysis. When taken off the cocoon, which was accomplished with considerable difficulty because of the beetle holding so persistently with its tarsi, the beetle seemed to be unable to walk or even stand, and when offered food it made vain attempts to eat. It seemed absolutely helpless from inability to co-ordinate its movements.

There were no serious results in this species from the glue thrown out from the cornicles of the large species of lice but this was probably only accidental and not because of any specific resistent character. Once, a small larva, apparently in the second instar, was observed to seize a full grown apterous *Macrosiphum ambrosiae* which appeared to be three times the size of itself. It first caught it by the right hind foot. The louse struggled, dragging the larva about for a minute or two and extruded glue from the left cornicle. The larva then managed to get hold just behind the right cornicle and proceeded to feed on the louse, though dragged about somewhat by the latter. Two and a half hours later it was found still feeding on the louse, which was still living, but had extruded no glue from the right cornicle on which side the larva was holding it. Unless for some reason the right cornicle contained no glue, this action of the louse seems to be explained only by awkwardness or stupidity. Indeed, the cases were extremely few when the louse seemed to make any well directed effort to smear its enemy.

Perhaps next in order might be classed several forms of *Adalia* Muls., namely, *melanopleura* Lec., *annectans* Crotch, *coloradensis* Casey, and *humeralis* Say. As these four forms interbreed freely and seem to be identical in life history it seems best to treat of them here as one species, which indeed they undoubtedly are. In the descriptions of the adults, however, they must be treated separately. In the larval and pupal stages they seem to be identical in appearance but in the adult state are strikingly different.

For full description of adults of these forms, see Annals of the Entomological Society of America, Volume 4, page 283.

Egg: Fig. J, Plate XIX*.

Pale to deep amber yellow in color as in the foregoing species. Length about 1 mm.; width about .5 mm.

Larva: Fig. I, Plate XIX*.

First instar: Head and pronotum shining black, rest of body dull black or dark grayish with a median row of paler spots from pronotum to tip of abdomen; 2nd instar, the same except lateral and mediolateral pale whitish spots on 1st abdominal segment and a median pair of whitish spots on 4th abdominal segment; pronotum bordered all around with whitish and with median pale line; 3rd and 4th instars; color often blackish gray or blue; median and anterior portion of head

*Annals E. S. A. Vol IV, Sept. 1911.

dusky or pale, a pair of pale spots on anterior lateral margin and three on posterior margin of pronotum; also a pale median line, and pale median portion of meso- and meta-thorax quite noticeable; spots on abdomen more noticeable than in previous instars. Legs black. Length of full grown larva 8-9 mm.

Pupa: Fig. H, Plate XIX*.

Ground color pale to sordid flesh color, tinged in places with brownish. Pronotum with pale median line and broad lateral portion pale, remainder dusky to black. Wing pads brownish to black, meso- and meta-thorax dusky to black except median pale line; each abdominal segment with three pairs of rows of dusky to black spots, median row lighter on 1st and 2nd segments, giving a lighter appearance to that part of the pupa. In dark specimens the markings are so extensive as to almost coalesce, giving quite a melanic appearance. Legs brownish to blackish. Length 4-5 mm.

Life cycle records were taken as follows:

Egg stage (84 records) 3-7 days in the spring, 2-6 in summer, mostly 3-5.
Larval stage (68 records) 11-18 days in the spring, 7-18 summer, mostly 15 spring and 11 summer.
Pupa stage (68 records) 5-9 days in the spring, 3-9 summer, mostly seven.
Egg to adult, mostly 21 to 23 days.
Adult (9 records) 1 month to 4 months, for the summer generations.

The records taken in the spring, April and May, it will be noted, covered more days than those taken in the summer, owing to the cooler temperature. Five beetles of first to third generation that had laid a considerable number of eggs and were from three to four months old, went into hibernation. One of these lived until April 4th the next spring, aged 8 months and 6 days. The rest died during the winter, though the hibernating quarters were excellent. As there is a probability that the first female captured, May 13, 1910, and with which the start was made in the breeding cage, was not a hibernating female, there is some uncertainty as to the number of each generation. The beetles which survived hibernation were the 4th or 5th generation and they survived in large numbers, about 150 beetles in all.

A pair of beetles, the female of which was 3rd or 4th generation *humeralis* that had laid no eggs, and the male 2nd or 3rd generation *annectans*, hibernated successfully, and in the spring the female laid eggs abundantly until June 12, 1911, and they both lived until June 16, 1911, the female aged nine months and the male nine months and four days. Almost all of the hibernating beetles which were cared for were still living May

23, 1911, aged about eight months, and a number were living June 12, 1911, but all died soon after, some being nine months old or more.

The females would usually begin laying about six days after emerging and continue for about three weeks. One continued for three months, by far the longest record made, but probably the most nearly correct as most records were doubtless cut unnaturally short on account of the great difficulty of keeping the beetles healthy in captivity. The hibernating females of all the three forms began to lay in six days after having been brought in from hibernating quarters and given food.

There seemed to be at least four, and possibly five generations during the season that the experiments were carried on, though 3rd generation and possibly 2nd generation individuals hibernated successfully. There was no evidence of any females which had laid eggs before winter hibernating and laying again in the spring, though it may possibly take place. The hibernating quarters used for these beetles were excellent and apparently gave the beetles every chance.

The earliest eggs were obtained April 10, 1911, and the first of the first generation reared emerged May 8, 1911. The latest eggs in the fall were obtained September 16, 1910, but if there had been no prematurely cold weather, the beetles might have kept on laying for several weeks longer. From two or three tests made, a female seemed not to be able to lay fertile eggs longer than three or four weeks after being separated from a male. If a new male was introduced, however, it seemed to affect the eggs almost immediately and after two or three days none of the progeny showed any of the characters of the former male, even when little or no interim existed between the males.

No feeding or counts were taken on this species as all the time in the work with these beetles was used in heredity investigation * and only such life history data as took but little time were noted. On general observation it was evident that they eat much less than the foregoing larger species, and in the breeding cage, at least, will not eat as large lice as the above ladybeetles. Probably out of doors, when the lice are quiet instead of restless as in the cages, they may feed upon

*See "Some Notes on Heredity in the Coccinellid Genus, Adalia Muls." Annals of Ent. Soc. of Am., Vol IV, No. 3.

larger species. Mr. Bragg says that he found them in numbers with *Prociphilus fraxinifolii*, a species which, from their large size and great quantities of honeydew, would have certainly brought disaster in the breeding cage, for great care had to be exercised in feeding these even to the larger species of beetles. They seemed to thrive in confinement on *C. negundinis*, *A. setariae*, *A. helianthi*, *C. populifolii*, *C. populicola*, *M. sanborni* Gill., *Myzus persicae*, Sulz., *Rhopholosiphum pastinacae*, *Aphis heraclei* Koch, *M. cynosbati*. Outdoors they were found with *P. fraxinifolii*. n 1910 and 1911 this species seemed especially abundant. In the spring of 1910 the box-elders were extremely lousy but by June 26, it was extremely difficult to find any *C. negundinis* excepting the dimorphic form which the ladybeetles seemed unable to eat. This species of beetles, together with Syrphus larvae, seemed to be chiefly responsible for the destruction of the lice. Again this spring, 1911, they seem to be the chief factors in cleaning up the box-elder lice which were almost killing some trees.

These beetles seemed to have a more delicate constitution than the other species reared and had to be tended with more care, and even with the best care, hardly 25 percent could be matured, and often less in the pure strains. The hybrids were much more vigorous, and of them it was often possible to rear 50 percent to maturity. These beetles were susceptible to all of the injurious influences which have been named, and besides, they seemed to object to what might have been an odor left by a certain species of ants, as the cottonwood *C. populifolii*, which is abundantly attended by ants, was rejected at times and accepted at others with no other apparent reason. On the occasion of rejection they would turn cannibal and almost the entire cage of larvae would be lost in one day, as though they had been left without any feed at all. It seems, however, that in spite of their seemingly rather frail constitution, they hold their own in nature pretty well, as during 1909 and 1910 and the spring, at least, of this year (1911) they ranked high in comparative numbers out of doors and doubtless have been very beneficial.

Olla abdominalis Say.

This species is sometimes found, though it is rather rare. One larva was found on a boxelder tree with *C. negundinis* June 25, 1909, and was reared to maturity. It was taken when nearly full grown.

Larva: Fig. 25, Plate XXXIII.

General color black, except medio-anterior portion of the head which was pale yellow to dusky; anterior portion of pronotum and median spot on posterior margin pale; median spots of pale yellow on meso-and meta-thorax; dorso-lateral yellow spots on first abdominal segment, and dorsal and dorso-lateral on 4th abdominal segment; lateral tubercles pale or partly so. Median pale spot on median posterior margin of each segment becoming larger toward caudal end of abdomen and giving the appearance of a pale median longitudinal line the entire length of the abdomen. Legs black.

This larva resembled the *Adalia* larvæ very much but grew to be somewhat larger than they did. Length of full grown larva 10 mm.

Pupa: Fig. 26, Plate XXXIII.

Ground color whitish tinged with yellowish and brownish in places. Markings as in *Adalia*. Length 5 mm.

Adult: Fig. 24, Plate XXXIII.

Head white except two black spots on the posterior margin; pronotum with (M) design as in *Adalia*, but with the white more extensive so that the pale spots often run together in places; elytra pale maize yellow, each with a row of four basal spots, a row of three just before the middle, the inner one crescent-shaped, also one subapical near the lateral margin. Sometimes this apical spot and the middle row are all connected into a triangular black patch. Legs brownish yellow. Length 4-6.5 mm.; width 4-5 mm. No work has been done with this beetle further than the rearing of the one larva found. This larva was found with *C. negundinis* on boxelder.

Coccinella sanguinea Linn.

This seems to be the species designated by Casey as *Cycloneda rubripennis* Casey, and by C. W. Leng as Subgenus *Cycloneda sanguinea* var. *rubripennis* Casey.

This species is comparatively if not indeed quite rare about Fort Collins, Colorado, but seems to occur more plentifully in the vicinity of Boulder, Colorado.

Adult: Fig. 27, Plate XXXIII.

Head black with broad white border next each eye, often also median pale spot and in many cases entire front of head white; pronotum black with rather narrow pale border along sides and extending posteriorly and internally along the base to about lateral sixth, apical pale line quite narrow with median acute line often rudimentary, also isolated sublateral pale spot which is sometimes narrowly connected to

the pale apical margin; elytra deep and bright scarlet with transverse pale spot on each side of scutellum; legs black to brownish, tarsi brownish; general shape broadly oval and rather strongly convex. Length 4.5 to 5.5 mm.; width 3.5 to 4.75 mm.

Egg: Fig. 28, Plate XXXIII.

Pale amber yellow; length 1.36 to 1.5 mm.; width .63 to .7 mm.

Larva: Fig. 30, Plate XXXIII.

First instar: Black or dusky with pale lateral spot on first abdominal segment, setaceous spots black as in other species. Second instar: Same as first except that fourth abdominal segment shows pale lateral and dorsal spots, and sometimes lateral pale spot appears on fifth and sixth segments, median of meso- and meta-thorax whitish to yellow. Third instar: Same as previous except that yellow spots on fifth and sixth segments and on median of thoracic segments are always pronounced and anterior margin of pronotum is also pale, median of abdominal segments whitish, giving effect of light median stripe; median and anterior portion of head brownish, while lateral and posterior portion is deep black; legs, especially front pair unusually long. Fourth instar: Same as preceding except that the spots are more yellow and lateral margins of all thoracic segments are pale whitish or yellowish; legs still longer than those of the other species studied; general color dark bluish. This larva strongly resembles the larva of *Olla abdominalis.*

Pupa: Fig. 29, Plate XXXIII.

Ground color pale maize yellow, darker in spots, especially in the depressions between the abdominal segments, a broad band along anterior and lateral margins and a round spot within lateral margin on each side of pronotum. Wing pads dark maize to honey yellow or sometimes quite brownish with posterior margins always brown; black markings as follows: Pronotum with a pair of black spots on anterior and another on posterior margin, also an anterio-lateral pair less pronounced, a pair of median spots on meso- and meta-thorax and on abdominal segments two to six inclusive, third segment with three pairs of spots; legs brownish honey yellow. Length 5 mm.

Life cycle records were made as follows:

Egg stage (7 records) 3-5 days, mostly 4 days.
Larva stage (7 records) 9-16 days, mostly 11 days.
Pupa stage (7 records) 3-5 days, mostly 4 or 5 days.
Egg to adult, 15 to 20 days.

This species has been observed by Mr. Bragg feeding on *Mac. solidaginis*, and in the breeding cages it did well on *Aphis heraclei* Koch., *Rhop. pastinaceae*, *Mac. gaurae*, *Mel. smithiae*, *Aphis setariae*, *Aphis oxybaphi*, and *Aphis helianthi.*

Some larvae of *Scymnus* species, determined by Major Casey as probably a new species somewhere in the vicinity of *cockerelli* Casey and *consobrinus* Lec., were reared but no life history notes were taken.

Adult: Fig. 31,Plate XXXIII.

Head black, yellowish red between the eyes; pronotum black with lateral thirds yellowish red; elytra black; legs brownish red; entire beetle covered with hairs; length 2.5 mm.; width 1.7 mm.

Egg:

Same color and shape as foregoing species but much smaller.

Larva: Fig. 32, Plate XXXIII.

Pale brownish throughout, but covered with six large tufts of waxy secretion on each segment so as to render the larva quite conspicuous.

In the pupa the larval skin is not pushed down as tightly as in the other *Coccinellids* studied, so that it gives the pupa a white cottony appearance and doubtless affords it considerable protection.

This species has often been found doing valuable service in keeping *A. setariae* in check on the plum. Professor Gillette has often found it abundant with *Schiz. lanigera* on the apple.

GENERAL SUMMARY.

In general appearance and color pattern these species of ladybeetles resembled each other most in the larval and pupal stages. *Coccinella 5-notata*, *9-notata*, and *monticola* resemble each other so much as to form one group. They of course had some characteristic differences but they often intergraded and merged together so as to be indistinguishable until they matured.

H. convergens, together with *H. parenthesis* and *H. sinuata* seemed pretty distinct in these stages but an occasional individual was found which seemed to show no distinguishing character. The *Adalia* beetles, *O. abdominalis*, and *C. sanguinea* seemed to form another group in color pattern of the larva and pupa. The forms of the *Adalia* seemed to be exactly identical in these early stages. *Scymnus*, of course, with its covering of waxy secretion, was entirely different.

In life cycle periods from egg to adult, all the species thus studied, *H. convergens*, *C. 5-notata*, *9-notata*, *monticola* and the genus *Adalia* seemed practically alike. From egg to adult in *H. convergens* took, as a rule, 21 days; in *C. 5-notata*, 20 days; in *C. monticola*, 23 days; in *9-notata*, 20-23 days; *Adalia*, 21-23 days. The age to which the adults lived seemed practically the same, two to three and perhaps four months for the summer generations. In *C. monticola*, however, it seemed that the first generation commonly hibernate so that these beetles would live to a greater age than even the hibernating beetles of the other species in which only the beetles emerging

later in the season hibernated. There did not seem to be any certain fixed generation to hibernate in any of the species but there was no evidence of any females that had laid eggs before winter hibernating and laying again the next spring, and none ever hibernated in other than the adult state.

Of all the species studied, *C. monticola* was the only one where there was any difficulty in breeding males in captivity; in all other species about half of the beetles reared were males, but here there was no evidence of any, and only females captured already fertilized, laid eggs which would hatch. Many of these captured laid infertile eggs or none at all, and none reared in captivity ever laid a fertile egg and most did not lay at all. For three years, no undoubted instance of the finding of a male occurred either biologically by myself, or by Mr. Bragg, who used dissection on captured specimens and had no difficulty finding males in any of the other species. Finally, however, two batches of eggs were reared with special care, one lot producing sixteen beetles from eighteen larvae hatched, and the second producing twelve beetles from twenty-three larvae hatched. The first lot proved, on dissection, to consist of seven males and nine females. The second lot consisted of nine males and three females. Why none have been observed mated, either in captivity or out of doors, and why Mr. Bragg found so much difficulty in capturing males, still remains unknown.

The egg laying periods seemed to be approximately the same for all these species where records were taken, both for the length of time for the individual, and for the laying season. A female would often lay before being fertilized but not as well as after. A female of *Adalia* would not seem to be able to lay fertile eggs for more than about three weeks after being isolated from a male. In *C. monticola*, on the other hand, if a female was once fertilized, it sufficed for the season. In *Adalia*, when a female was changed from one male to another, the later male would take precedence over the former one, almost immediately, so that the eggs laid two or three days after and later would develop the characters of the later male in every case.

In the individual egg records, *C. 9-notata* ranked first, the four highest records being from 435 to 1047; *C. 5-notata* next, with 368 to 539; then *H. convergens* with 199 to 312, these numbers representing the four highest records of each species

respectively. Owing to the difficulty in getting these beetles to lay their full number of eggs in captivity, many of the numbers here may fall far short of what the beetles are able to do, and the differences between the species may have been more or less accidental, though *C. 9-notata* seemed very decidedly to be the most prolific.

Considering the feeding capacity of the larvae and adults of these species, there seemed little difference between them. A larva of *H. convergens* was able to eat 100 *C. negundinis* in a single day, and the highest entire record was 576 aphids of different kinds. A larva of *C. 5-notata* could eat 100 *C. negundinis* in a day and the highest entire record was 620 aphids. A larva of *C. monticola* ate 144 to 190 *A. cornifolii in* a single day, and the highest entire record was 962 aphids. An adult of *H. convergens* ate 120 *A. setariae* in a single day, and one of *C. 5-notata*, 200 *A. helianthi.*

Both in the per day, and the entire record of the larva, *C. monticola* leads, and *C. 5-notata* ranks second. These species are on the whole practically alike in feeding habits and what differences there seem to be may be partly accidental as counts were taken on only four larvae of *H. convergens*, only two of *C. 5-notata*, and five of *C. monticola*, and only two counts of *C. monticola* exceeded the other species, the other three being no higher than in the others. The amount eaten per day varied greatly with the larvae according to the weather and the size of the larva, and in the adult it varied with weather and egg laying.

In range of feed *H. convergens*, *C. 5-notata*, *C. monticola* and *C. 9-notata* seemed practically alike and seemed to comprise everything in the way of aphids except aphid eggs, though the smaller species seemed to be preferred in the breeding cage. Out of doors they all seemed to feed on the large species as well as the smaller ones. For these four species of ladybeetles the following plant lice were used as feed: *A. cerasifolii*, *A. gossypii*, *A. oenotherae*, *A. carbocolor*, *A. taraxici*, *A. torticauda*, *A. oxybaphi*, *A. helianthi*, *A. setariae*, *A. medicaginis*, *A. brassicæ*, *H. arundinis*, *Lachnus* sp., *C. negundinis*, *C. populidola*, *C. populifolii*, *M. gauræ*, *M. cynosbati*, *M. pisi*, *Myzus cerasi*, *Macrosiphum ambrosiæ*, *M. rudbeckiæ*, *Prociphilus fraxinifolii*, *Phorodon humuli*, *S. lanigera*, *Melanoxantherium bicolor* and *M. smithiæ.*

There was no evidence of any of these species feeding on vegetable matter, though they often chew and suck about on the leaves when very hungry and one newly emerged *Adalia* beetle seems to have chewed up a portion of a half dried boxelder leaf.

The *Adalia* beetles had to be fed on only the smaller species of plant lice in the breeding cages, though out of doors they were found by Mr. Bragg to be quite abundant with *P. fraxinifolii.* Early in the spring, 1910 and 1911, they were very abundant with *C. negundinis* and together with the Syrphus larvæ they cleaned these lice off the boxelder trees, though they had been very badly infested. The species used successfully in the laboratory were *C. negundinis*, *M. sanborni*, *Myzus persicæ*, *A. setariæ*, *A. helianthi*, *R. pastinacæ*, and *Macrosiphum cynosbati.*

The injurious influences affecting these species were cool damp weather, which *C. monticola* seemed to stand better than the other species, very large lice that would extrude large quantities of glue from their cornicles, a fungous disease resulting from too much dampness in the cage or perhaps from the decaying bodies of half eaten lice, and frequently beetles were destroyed by a hymenopterous parasite known as *Perilitus americanus.* Ants, also, seemed to be hostile, in one instance killing a larva and in another, an adult, this even in the breeding cage where the ants felt strange and were frightened. Much loss was occasioned by cannibalism, eggs, larvæ, pupæ, and even newly emerged adult beetles, while still soft, being eaten by hungry brothers either larvæ or adults.

As to members in nature, the different species seem to rank differently in different years. From casual local observations, in 1907 and 1908, *H. convergens* ranked first, *C. 5-notata* second, *C. monticola* third, *C. 9-notata* fourth, and *O. abdominalis* and *Adalia* quite rare. In 1909, *C. monticola* was first, *Adalia annectans* second, *H. convergens*, *C. 5-notata*, and *C. 9-notata* not very abundant, and *O. abdominalis* only occasional.

EXPLANATIONS OF PLATES.

Plate XXXII.

Fig. 1. Adult of *Hippodamia convergens* Guer.
Fig. 2. Eggs of *Hippodamia convergens* Guer.
Fig. 3. Larva of *Hippodamia convergens* Guer.
Fig. 4. Pupa of *Hippodamia convergens* Guer.
Fig. 5. Adult of *Hippodamia sinuata* Muls.
Fig. 6. Pupa of *Hippodamia sinuata* Muls.
Fig. 7. Larva of *Hippodamia sinuata* Muls.
Fig. 8. Eggs of *Hippodamia sinuata* Muls.
Fig. 9. Adult of *Hippodamia parenthesis* Say.
Fig. 10. Eggs of *Hippodamia parenthesis* Say.
Fig. 11. Larva of *Hippodamia parenthesis* Say.
Fig. 12. Adult of *Coccinella 5-notata* Kirby.
Fig. 13. Eggs of *Coccinella 5-notata* Kirby.
Fig. 14. Larva of *Coccinella 5-notata* Kirby.
Fig. 15. Pupa of *Coccinella 5-notata* Kirby.

All drawings magnified five diameters.

Plate XXXIII

Fig. 16. Adult of *Coccinella monticola* Muls.
Fig. 17. Eggs of *Coccinella monticola* Muls.
Fig. 18. Larva of *Coccinella monticola* Muls.
Fig. 19. Pupa of *Coccinella monticola* Muls.
Fig. 20. Adult of *Coccinella 9-notata* Hbst.
Fig. 21. Eggs of *Coccinella 9-notata* Hbst.
Fig. 22. Larva of *Coccinella 9-notata* Hbst.
Fig. 23. Pupa of *Coccinella 9-notata* Hbst.
Fig. 24. Adult of *Olla abdominalis* Say.
Fig. 25. Larva of *Olla abdominalis* Say.
Fig. 26. Pupa of *Olla abdominalis* Say.
Fig. 27. Adult of *Coccinella (Cycloneda) sanguinea* Linn.
Fig. 28. Eggs of *Coccinella (Cycloneda) sanguinea* Linn.
Fig. 29. Pupa of *Coccinella (Cycloneda) sanguinea* Linn.
Fig. 30. Larva of *Coccinella (Cycloneda) sanguinea* Linn.
Fig. 31. Adult of *Scymnus sp.* magnified 8 diameters.
Fig. 32. Larva of *Scymnus sp.*

All drawings except Fig. 31 are magnified five diameters.